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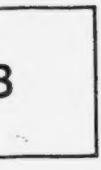

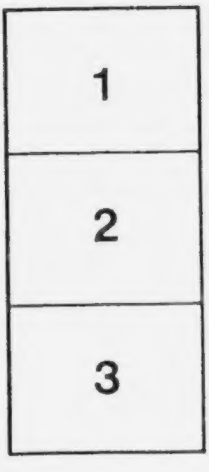

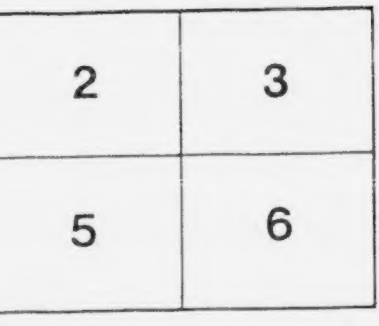

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The

Principles of Soil Fertility

Applied to the Worn-Out Dyked Lands.

By PROFESSOR W. W. ANDREWS
SACKVILLE, N.B.

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THE PRINCIPLES OF SOIL FERTILITY APPLIED TO WORN-OUT DYKED LANDS

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THE PRINCIPLES OF SOIL FERTILITY APPLIED TO THE WORN-OUT DYKED LANDS

Every soil may be described as a mass of very small rocks of the same general composition as the original rock from which they were formed. This is strictly true, except in those cases where a rock made of several minerals, has been subjected to a sorting process which has resulted in the quartz being deposited as sand in one place and the feldspar as a clay in another, as frequently happens in disintegrated granite. A soil, therefore, is not really exhausted until it is worn completely away, for each little rocklet contains the same percentage of fertilizing elements as the original rock. The researches of Prof. Shutt and his fellow-workers at Ottawa show that, locked up in the fragments composing the average Canadian soil, to a depth of eight inches, in a slowly available form, there is sufficient nitrogen, potash and phosphate to support continuous cropping for 200 years. The disintegration of these rocklets is effected by means of oxygen and carbonic acid, by lime, potash and other alkalies, and by mineral and organic acids, some of which last are exuded by the rootlets of plants, and some are produced by bacteria. When a soil seems to be exhausted, there is either a deficiency of the elements of plant food in the soluble state, a deficiency which most frequently arises from the destruction of the humus or vegetable mould, which is the chief moisture-holding and bacteria-feeding element in the soil, or from a poisoning of the soil, due to an excess of acids and other hurtful excretions left in the soil by plant growth and plant decay.

The problem of treating the soil, therefore, reduces itself to two heads:—First, preventing poisonous conditions by means of drainage, cultivation and liming, and, second, producing a large amount of available plant food.

Drainage and cultivation have a well-known result in sweetening a soil, through the water and air interchanges they effect in the soil. A water-logged soil

very quickly becomes poisonous to crops needing cultivation. When the poisonous condition is an acid one, lime and wood ashes, the cheapest of our alkalies, are very efficient in restoring healthful conditions. Basic slag phosphate and basic superphosphate, on account of the large amounts of lime they contain, are also useful.

To produce a large amount of available plant food a great many agencies must be brought into play. We can supply them directly in barnyard manure, or in chemical fertilizers, whose chief value is bringing powerfully into play other agencies, and thus increase many fold a farmer's mastery of his conditions. By their wise use he can supplement nature's work and make them set free other chemicals for the use of his crops.

The most important element in the soil is the humus, which produces valuable chemical conditions, and supports that bacterial life, whose function seems to be to prepare food for the plants, much as the plants prepare food for the animals. It can be supplied to the soil by the addition of barnyard manure, swamp muck, or by plowing under green crops, such as clovers, rape, peas, vetches, etc. Almost any soil, if well supplied with humus, will, if properly drained and cultivated, respond to cultivation as well as a "virgin soil." Chemical fertilizers can do an invaluable work in stimulating the growths to be used in adding to the soil's supply of vegetable mould. Cultivation, stimulating chemical fertilizers, and lime, quicken the chemical changes in the soil and the bacterial life which feeds upon the humus in preparing plant food, and therefore alike, they tend to give great results and a quick destruction of the humus. He who opens the draft, and, by stirring, stimulates his fire, gets greater results, but fuel must be supplied at a greater rate to sustain the flame. So it is with the humus. The adage is true—

> Continued liming without humus
> Brings the farmer to the poorhouse.

and also

> "Lime and lime without manure
> Makes both farm and farmer poor."

The great excellence of barnyard manure, as compared with purely chemical fertilizers, is that, in addition to the available chemical elements it contains, it consists chiefly of a mass of humus swarming with bacteria. A plowed-under sod becomes a similar mass of humus. In the case of black muck lands, which are masses of almost pure humus, there is no possibility of doing permanent harm to the soil by the excessive use of lime or by any other form of stimulation.

THE STANDARD ELEMENTS OF PLANT FOOD

The standard elements of plant food are phosphoric acid, potash and nitrate nitrogen. Broadly stated, the functions of these may be stated as follows: The nitrates favor rapid and luxuriant growth, and, therefore, should be plentifully supplied to all crops which require a rapid start or in which we look for tender succulence, such as lettuces, cabbages, etc. Phosphates are necessary to all life, but they are especially called for in the formation of seeds, and, therefore, by a supply of phosphate we can ensure the heading up of grain crops. Potash favors the production of sap, wood fibre, sugar and starch. It gives strength of stem and bulk, and, therefore, may be used in large quantities on hay crops, potatoes, fruit trees, turnips, mangels, sugar beets, tomatoes, etc. If grain lodges it is due to a deficiency of potash. All three elements must be supplied in due proportion if the highest rate and quality of growth are to be obtained. Potash shares with lime the power of aiding the growth of legumes, which furnish us with the cheapest and best method of supplying the costly nitrates to the soil. It is still a moot question whether these three elements feed the plant directly or aid the food-preparing bacteria which serve the plants. This much is well established, that when a soil is rich in humus and kept well ærated, the bacteria prepare nitrates in the soil, and that this work goes on in a truly marvellous way in the nodules found on the roots of such leguminous plants as clovers, peas and vetches, etc. When, therefore, a clover mat is plowed under, we not only add nitrogen to the soil, and the potash and phosphate which

the clover plant has wre from the soil, but the acid and heat of its decay ... the swarming bacterial life unlocks additional chemical elements from the rocklets of the soil. Therefore the soluble forms of potash and phosphoric acid are not stimulants, but true plant foods supplied in a form in which, directly or indirectly, the plants can avail themselves. So that if a soil has "run out" by over-stimulation with lime, or over-cropping without manuring, the quickest and surest way to restore the fertility is to apply the plant food, to obtain a good clover growth, which, if plowed under, will supply large amounts of nitrogen and of humus, which will ensure under the process of cultivation a continued supply of nitrate through bacterial activity, and the unlocking of further supplies of potash and phosphate. Wherever this unlocking process is not rapid enough to support heavy cropping, then the application of quickly available fertilizers is called for. Furthermore, it has been conclusively shown that there must be free in the soil an excess of fertilizing elements, above what a plant can take up into its tissues, if it is to show its most vigorous growth. Otherwise the plant spends part of its time and energy in wasteful underground foraging for food.

One of the most pressing problems in agriculture in the Maritime Provinces is that of restoring the lessening fertility of the wonderful dyked lands of the Bay of Fundy. One remedy is certainly effective, viz., opening the dykes and covering the lands with a new tidal deposit. But in hundreds of cases this is practically impossible on account of its cost. It means the loss of saleable crops for six, seven or eight years, and this, with all the incidental expenses, brings the cost up to $75 or $100 per acre. One such treatment is probably good for one hundred years. Or we may haul tidal mud from the river banks, and, at a cost of from $30 to $60 an acre, we can cover the land with a coating which will last for eight or ten years, or we may add chemical fertilizers, potash and phosphate, and, at a cost of from $10 to $18 per acre, and without any loss of crop, we can produce a highly fertile marsh which will bear luxuriant crops of hay for six years at least after one application. After that length of time its supply of humus should be rein-

MR. GEO. THOMPSON'S EXPERIMENT ON THE WOLFVILLE MARSHES

Fertilized with 1120 lbs. Basic Slag, 500 lbs. Bone Dust and 200 lbs. Muriate of Potash

MR. GEO. THOMPSON'S EXPERIMENT ON THE WOLFVILLE MARSHES

No Fertilizer

forced by plowing under an aftermath, as heavy as possible. A slight dressing of lime would tend to correct any acidity arising from the souring of the succulent mass buried by the plow.

Grass lands tend to sourness, and, therefore, old pastures run to moss, sorrel weeds and wire-grass. This condition is found frequently on the poor tidal lands. What treatment does this unique soil demand to restore its fertility?

The tidal mud is a remarkably fine-grained silt, which, on account of its fine-grainedness, exposes a very large surface to solvents, such as water and carbonic acid, which unlock the fertilizing elements. This accounts for the fact that, though it carries but a small total percentage of fertilizing elements, it is able to support luxuriant crops, since each rootlet of the thousands on a single grass plant is able to reach some unlocked plant food. However we account for the decay of fertility, it is clear that the grains which are left in "worn-out" marsh are of the same chemical composition as the original tidal deposit.

There are two main classes of dyked lands—the red and the blue. The latter contains a notable amount of sulphide of iron (Fe S), which sometimes decomposes into hydrogen sulphide, with its rotten egg odor. The iron sulphide, on exposure to the air, changes into green vitriol, the sulphate of iron (Fe SO4), and both it and the sulphide are poisonous to plants and bacteria. If quick-lime (Ca O) be added it will change the green vitriol into sulphate of lime, or gypsum, and the iron becomes oxidized if exposed to the air into the red oxide (Fe2 O3), which, on account of its power to act as a carrier of oxygen, is a quickener of both chemical and bacterial changes, and, on account of its power to aid the formation of the green matter of plants, is both directly and indirectly an aid to plant life. It is plain, therefore, that if lime be used on the hay marshes, land plaster (gypsum) need never be. And as there is sure to be a sufficiency of sulphates in the soil, no sulphate manures should be used, nor bone meal or phosphate which has been brought into an available form by the use of sulphuric acid, except with great care.

Experiments on the marsh at the Nappan Experimental Farm, and on some sections of the Wolfville dyked lands, seem to indicate that artificial nitrates are of doubtful value on the tidal lands. Good results have been obtained by the use of lime, soluble potash salts, basic slag phosphate and bone meal. These are precisely the fertilizers which stimulate leguminous growths, and, therefore, by their use we may supply to the soil all the nitrogen required. These fertilizers are cheap as compared with the nitrates, and this at once makes easier the profitable solution of the problem.

PRACTICAL TESTIMONY

In the replies which came to the several hundred lists of questions which the writer sent out to the owners of dyked hay lands there was practical unanimity as to the beneficial effects of the above named fertilizers wherever they had been used. One case, in which a few ridges had been treated wtih lime twenty-five years ago, Mr. Geo. Thompson, of Wolfville, reports that the good effects are yet visible. Mr. Rupert Black, of Amherst, reports that his father treated a piece of dyked land with lime fifty years ago, and the effect is still noticeable. Mr. P. McNutt Patterson, of Acacia Villa School, reports a case in which the effects of a slight dressing of lime were observable after forty years. The use of lime on the tidal mud may be summed up thus: It will tend to cure acidity, with the consequent mossiness and corkiness, it changes the poisonous iron salts into gypsum and iron oxide, sets free the potash from the silicates of the soil, makes more available the locked up phosphates, and with the potash stimulates the growth of clovers.

Mr. Geo. Thompson, whose experiments have been on the largest scale, and the most carefully conducted, and who sent answers which were models of clear statement, writes that he finds three casks of lime per acre to be generally sufficient, and that six casks per acre was the limit of beneficial treatment.

As to the use of other fertilizers, Mr. Thompson's testimony is as follows: "In 1894 I dressed a four-acre dyke lot with five casks of lime per acre, and

sowed it down to grass with oats, and late in the fall sowed one-half a ton (1,120 pounds) of basic slag phosphate per acre. Previous to plowing the lot it was nearly covered with oxeye daisy, and light at that. The oat crop was good, and last year the grass cut three tons to the acre, the clover a grand growth. I measured some of the timothy stalks and they stood five feet two inches above the ground. On an adjoining lot last year I spread 500 pounds of bone dust per acre and 200 pounds of muriate of potash in the spring, sowed down to grass with oats, had a fair crop of oats and a good catch of clover and timothy. Late in the autumn I sowed half a ton of basic slag per acre, and now await results." Personal examination the following year, and written reports of the grass sales on these areas from parties in the neighborhood, and the accompanying photographs, show how well Mr. Thompson's faith has been justified. It has been proven that three tons of hay per acre is an ideal which can be reached. "My conclusions are that a dressing of lime and basic slag are the best for the blue dyke, and for red dyke, bone meal, muriate of potash (KCl) and basic slag. This has lasted for six years."

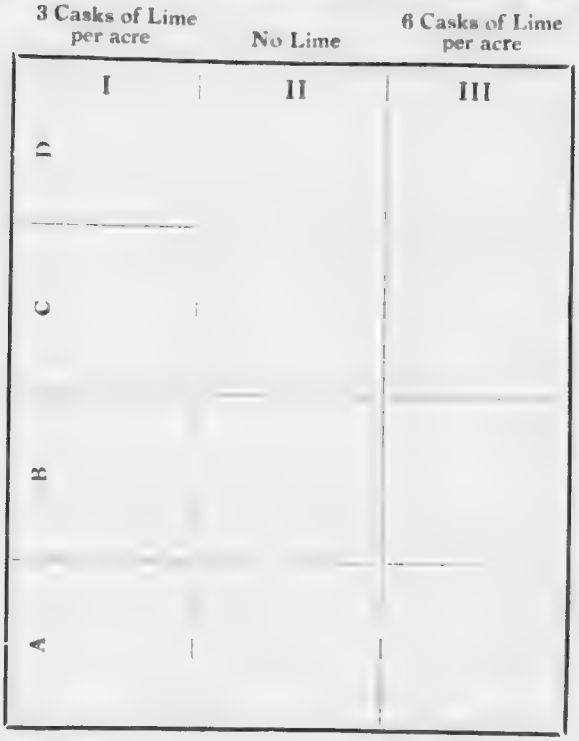
As the blue dyke is a poorly aerated soil which by proper drainage and cultivation will become red, in the end the same treatment is required by both soils. Certainly after the lime and cultivation have corrected the acidity and set free some potash for the first crop, the addition of soluble potash and available phosphate immediately after the cutting of the crop will show beneficial results in the following year's growth.

Mr. Thompson is an enthusiastic advocate of underdraining by means of crock tiles at a minimum depth of two feet, and laid with a slope of not less than one inch in one hundred feet. These be laid and covered in the old ditches, covering the joints with strips of zinc. This leaves a level dyke, unbroken by ditches, and therefore easier to work. The general testimony has been, as to the advantages of underdraining, as follows: It has resulted in an increase of crop-bearing surface of ten per cent., in an increase of crop of from twenty to thirty per cent., in less trouble with

surface water, in finer texture of soil and greater power to withstand drouth.

PLAN OF EXPERIMENT RECOMMENDED

Let an acre be staked out into three parallel strips of equal width, to be marked I., II. and III. Crossing these at right angles four equal and parallel strips and lettered A, B. C, and D. Treat each strip with the fertilizer, and in amount printed opposite each strip. Sow with grain, seed down with timothy and clover, and harrow in well. On grass lands no fertilizer should be plowed in. Disc harrowing is sufficient. The fertilizer may be applied after plowing in the fall with often greater benefit. This is especially true of basic slag phosphate and bone meal.


3 Casks of Lime per acre
No Lime
6 Casks of Lime per acre
I
II
III
D
C
B
A
100 lbs. of Muriate of Potash or 400 lbs. of Kainit.
100 lbs of Muriate of Potash or 400 lbs. of Kainit and 500 or 800 lbs. of Basic Slag Phosphate.
Neither Potash nor Phosphate.
500 or 800 lbs. of Basic Slag Phosphate (Thomas Phosphate Powder)

In conclusion, enough has been determined by actual results to make every owner of tidal hay lands ready to test the matter upon his own marsh and become a self-convinced experimenter. The plan outlined above can be carried out by any farmer with little trouble or expense

on at least one acre, and must yield results which will guide him safely in the future treatment of his dyked lands. If several hundreds of marsh owners should make such experiments the mass of testimony would prove of immense value to this section of Nova Scotia and New Brunswick. One warning should be given. On old sour dyked lands and on the blue dyke the use of lime alone is apt to give results so encouraging that some may be tempted to depend upon it alone. It has great value as a corrective to acid conditions in the soil, and to the poisonous oxalic acid which is produced in the sap of plants. In this way it makes plants more resistant to disease. As it is a plant food in a limited sense only, its continued use as a stimulant may result in the end in a thoroughly impoverished soil. The main dependence should be placed upon the true plant foods.

¶ FURTHER copies of this booklet as well as of other similar publications treating of the various farm crops may be obtained GRATIS by addressing : : : : : : :

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